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NORTHEASTERN FOREST EXPERIMENT STATION

Division of Watershed Management Research

Semi-annual Report October 1954

GENERAL

Since we didn't report on our work in the last semi-annual report, this will cover, in a brief way, a year's work. During that year a number of things happened which affected our program, ranging from last fall's drouth to this summer's Congressional appropriation for watershed research in New England. Between times we had a fire on the Dilldown, several personnel changes (not related to the fire), and a consolidation which merged the Delaware Research Center with the Anthracite. We've had our share of visitors and in turn visited our share. And we chalked up another water year calibrating our watersheds.

KINGSTON RESEARCH CENTER

This report marks the end of the Delaware Basin Research Center as a separate entity and the end of our six-year association with Lehigh University. Effective June 1, the office in Bethlehem was closed and the files, furniture, and equipment were moved to Kingston, Pennsylvania, the headquarters of the Anthracite Research Center.

The Kingston Research Center, the official name of the consolidated center, was formed in the interests of economy and to promote greater efficiency. Both the Delaware-Lehigh Experimental Forest (Dilldown Watershed) and the Pocono Experimental Forest are closer to Kingston than to Bethlehem. Watershed studies at both forests will be continued as usual.

Trough-type Raingages

In interception studies trough-type raingages have certain distinct advantages over the standard circular, 8 inch diameter gages. They can be made up very cheaply. In measuring throughfall in brush cover, a long narrow trough samples throughfall under a considerably larger variety of cover conditions than a circular gage can possibly sample.

Accordingly, trough-type gages were used in our interception studies, both in scrub oak and high forest. Three gages were placed at random beneath the canopy, while a single gage was located in a nearby opening to measure total rainfall.

(Over)

In actual use, the surface area of the mouth of the gage is measured, and if placed on a slope to drain adequately, corrected by the degree of slope. Theoretically, a hemispherical trough such as a standard eaves gutter will catch and hold (or deliver to a container) all the rain falling into it.

Nevertheless, the suspicion arose that our trough gages were not catching an adequate sample of rainfall. As a preliminary test, standard weather-bureau type raingages were located immediately beside the trough-type gages in the open and comparative measurements were made. At every installation where these comparative measurements were made, the circular gage caught more rainfall than the comparable trough gage.

A gage will not catch more rain than falls, but it is possible for rain to splash out of or be blown away from a gage. Therefore, when there is a varying catch in two adjacent gages, the higher amount is taken as the best estimate of the rainfall. We were forced to conclude that our trough gages in the open were not catching a typical sample of total rainfall.

Following the reasoning that some of the rain must have splashed out of the trough gages, new gages were made with 3-inch vertical sides above the hemispherical part of the trough to reduce splash. To test the effectiveness of the new gage, a more detailed study was conducted this past summer.

In the opening at one of our interception stations, a series of circular gages were placed with one of the new, high trough gages and four of the old, low trough gages. The old gages were sloped in each of the four cardinal directions in an attempt to determine some effect of wind on the deficiency of the catch in the low troughs.

Analysis of the measurements is now nearly complete and some tentative conclusions have been reached. The low trough gages again caught less than the circular gages. On a seasonal total, the differences are important. Variation between the circular gages was very slight; seasonal differences were negligible. The higher trough gage caught slightly less rain than the circular gages but the difference was not significant.

We have been able to detect no effect of wind direction or the direction in which the trough gage was sloped. Degree of slope, an unsuspected variable, appears to have had an effect on the catch: the greater the slope, the greater the catch. The trough with the greatest slope, 11 degrees, had the highest total catch; the difference in catch between it and the high trough was barely significant. The catches in the other three troughs were highly significant in their differences from the high trough. The differences were inversely related to the degree of slope.

Averaging the four low trough gages, the catch per storm was related to the best estimate of the rainfall for the respective storm. With P representing the best estimate of the rainfall, and T representing the average catch in the trough gages, then $P = 1.041T + 0.008$. The equation shows a considerable difference between the trough gage catches and actual rainfall. Thus, our previous interception determinations may be revised considerably.

Soil Freezing

This past winter we initiated a laboratory study of soil freezing with the specific objective to determine the soil, water, and temperature characteristics important in the formation of different types of frozen soil. The study was limited to three textures; soil, loam, clay; three levels of freezing, 25, 15, and 0° F, and a range of moisture content from oven-dry to saturation. Soils were frozen in a small home freezer.

By controlling these variables we were able to manufacture only concrete frost. This frost was of two types: one with visible ice lenses or strata, the other a consolidated mass of soil with varying degrees of hardness which contained no visible water in crystalline form. We have called the latter type "homogeneous concrete frost." This type has been encountered often in the field, but was always identified as concrete frost.

Within the limits set by the experiments, we found that texture has a decided influence on frost type. In sands, only homogeneous concrete frost formed. In loams concrete frost formed but only thin ice lenses were generated. In clays concrete frost formed, but the frozen water took the form of ice strata.

Moisture content also affects the freezing of soils. First of all, some moisture must be present for the soil to assume a consolidated form. Oven dry soils and those with a low moisture content remain unconsolidated. Some moisture must be present to bind the soil particles together. The amount of moisture required depends on the soil texture. Thus, sandy soils require only a small amount of water, whereas clays require a great deal more water to bind the particles. The requirement of loams lies between the two extremes.

A second effect of moisture content is on the hardness of the frozen soil mass. Although precise measurements were not taken on the force required to crack open a frozen soil, it was evident that soils with high moisture levels froze into a very hard mass, whereas those with less water did not freeze as hard.

The effect of rate of freezing was difficult to detect. Beyond the obvious result that soils frozen at 0° F. froze much faster than those frozen at 15° F. or 25° F., there was only one other discernible effect: sandy soils frozen at 25° F. did not freeze very hard, whereas those frozen at 0° F. did freeze into a hard mass, the degree of hardness depending on the moisture content.

Apparently the most promising avenue of approach toward producing granular or honeycomb frost lies in studying the effects of compaction and structure.

<u>Fire</u>

On October 21-22, 1953 fire burned over 325 acres in the lower part of Dilldown Watershed (total area 1800 acres). The watershed project is still in the period of calibration and fire is not an unusual condition in the natural state of the watershed. The burned area contained the oldest and largest vegetation on the watershed aside from the high forest along the creek.

<u>Scrub Oak Conversion</u>

Anticipating the end of the calibration period of the Dilldown Watershed, plans are being made to change the present vegetative cover to a high forest cover. Most of the watershed is now covered with brush, pure scrub oak in some places, elsewhere scrub oak with an intermixture of chestnut, pitch pine, red and white oak, red maple, gray birch, and sassafras.

These other species, with the exception of chestnut, are emerging from the scrub oak cover and will compete successfully with the intolerant scrub oak. Where these species are frequent enough, they will form a closed canopy if protected from fire. Other areas may need some supplementary interplanting to complete the high forest cover. Pure scrub oak areas will require complete conversion, of course, as the natural conversion process is extremely slow with no competing vegetation.

The gray birch, sassafras, and possibly red maple will have no commercial value but are considered to be adequate to form a closed canopy for the watershed studies. To form a complete cover of commercial species would be more expensive and much more difficult.

Reigner has spent considerable time on this planning, using information gathered in the vegetation survey of the watershed. Several alternative plans will be prepared, using the various conversion methods now considered practical.

Soil Moisture Installations

Additional soil moisture units were installed at two sites. The thought behind the installation of these units was that the data they furnished would eventually replace those yielded by deteriorated units installed a few years ago. In this way, a continuous source of soil moisture data would be available.

Groundwater Measurements

The watershed study at the Pocono Experimental Forest has never had groundwater control. Without a well into groundwater, it is difficult if not impossible to determine base flow or to determine when recharge occurs.

After the dry summer experienced in the Poconos, groundwater was at a low level. Accordingly, test holes were dug to determine where groundwater could be measured without the expense of drilling a deep well. The first hole was dug in a flat area about 75 feet from the stream. Water was reached at a rather shallow depth, but lay at the same level as the stream. As this well was obviously being recharged by the stream, a second hole was dug at a higher level, and farther from the stream. Water was also struck at this location and its level is higher than the stream surface. Further testing is necessary, but it appears that the second location will be suitable for the development of a shallow groundwater well.

Infiltration Project

The Northeastern Extension of the Vicksburg Infiltration Project began operation at the Kingston Research Center in June. The purpose of this work is to determine soil strength characteristics and check soil moisture predictions at representative soil-cover sites.

Working with available Soil Survey maps, 133 sites were selected in six northeastern states, Pennsylvania, N. Y., Conn., Mass., N. H. and Vermont. To facilitate efficient and economical sampling trips, the area was divided into two circuits, eastern and western. The eastern circuit covers eastern N. Y. and all states east. The western circuit covers Pennsylvania and western N. Y. Mileage and number of sites are similar for each circuit.

The sampling schedule calls for five visits to each site before the soil freezes. To date, three visits have been made to the eastern circuit and four to the western circuit sites. On each visit soil moisture and soil strength measurements were taken. Bulk samples were taken on the initial round and have

been sent to Vicksburg for mechanical analysis. Remolding data and ring cores for bulk density and tension data will be taken when the soil is moist.

Ralph Moyle, transferred here from Crossett, Arkansas, is in charge of the survey. He is assisted by Beryl Jones, transferred from Colorado, and Arthur R. Eschner transferred from Central States.

MOUNTAIN STATE RESEARCH CENTER

The Elkins-Parsons combine is generating considerable interest in studies of logging road design and construction. The aim has been to develop logging methods by which the logs can be brought out of the watershed without bringing the soil too. In the next-before-last semi-annual report was described first year results from vegetating skid roads with chaff. The results, by treatment, for the second year parallel the first year's results.

Mechanical disturbance caused no significant difference in cover density either on the limed and fertilized plots or the plots which were not limed and fertilized.

The limed and fertilized plots showed a significantly greater percent of vegetative ground cover (at the 1% level) than the plots which were seeded but not limed and fertilized.

The control or untreated plots showed significantly less cover density than either of the other two groups.

Table 1.--Treatment Effects on Vegetation Density

Treatment	Percent Ground Covered by Vegetation		
	First Year: 1953	Second Year: 1954	Increase the second year
Seeded only (A&B)	26.0	34.0	8
Seeded, limed & fertilized (C&D)	40.0	59.0	19
No seed or treatment (E)	0.5	16.0	15.5

Species composition changed appreciably the second year. Timothy became the predominant grass species; the proportion of the cover made up of weeds increased sharply; local herbaceous forest species entered into the composition; and maple reproduction was frequent.

In general, plots which were seeded, limed, and fertilized have produced a vegetation cover which in its second year is an effective erosion retardant. It is doubtful if on the other plots the sparse vegetation now present is offering much protection against soil washing.

This year our revegetation study has been broadened to include a section of logging truck road, additional soil types, and the seeding of Sericea lespedeza as well as chaff.

Bear Run Truck Road Study

Logging in this hollow began in November 1953 and will end in the spring of 1955. We have found that during rainy weather the amount of sediment in the water has increased 20 to 30 times what it was before disturbance of the hollow. Where the water was once pure and fit for any use practically all the time, it now runs free of silt only at very low flows during dry spells. Eventually we hope to learn how long it takes nature to "clean up" a stream after logging.

Watersheds

Calibration of our 5 gaged watersheds is continuing. We have three years of record and in a couple more years we will begin cutting to show the effect of different types of forest management and road standards on these water values: sedimentation, total water quantity, peak flows, low flows.

WHITE PINE HARDWOOD RESEARCH CENTER

Watershed management research in New England will start this winter. Currently, we have two jobs--find an experimental area and develop a research program. Vic Jensen, research center leader, Lull, and Trimble have been conducting a search and hope to have an area picked out shortly. The program--we're thinking about it and we've asked some leading thinkers to help us out.

The work was made possible by a $50,000 Congressional appropriation this past August. It culminates years of planning and hoping--the Copeland Report called for this research in 1933.

Present plans call for Dick Trimble to head up the Project assisted by Dick Sartz from the Washington Office PI Project, and others to be appointed later.

PERSONNEL

In mid-January this year Herb Storey moved to Washington, D. C. to take on the job of Chief, Division of Watershed Management Research.

In June Ned Bethlahmy took educational leave to attend Cornell in quest of a Ph.D., majoring in soil physics.

In August Howard Lull turned up to take Mr. Storey's old job.

PUBLICATIONS

1. Do We Need Watershed Research in West Virginia by Sidney Weitzman, West Virginia Conservation, February 1954.

2. Foresters Are Important on the Watershed by G. R. Trimble, Jr., West Virginia Conservation, March 1954.

3. Effects of a Hardwood Forest Canopy on Rainfall Intensities by G. R. Trimble, Jr., and Sidney Weitzman. Trans. A60, April 1954.

4. Report No. 2. Forest and Water Research Project, Delaware-Lehigh Experimental Forest by H. C. Storey, W. E. McQuilkin, and Eugene McNamara, Pa. Dept. of Forests and Waters.

5. Estimating Summer Evapo-transpiration Losses in a Pennsylvania Scrub Oak Forest by Ned Bethlahmy, Soil Sci. Soc., Amer. Proc. 17:295-297.

6. Technical Articles by Ned Bethlahmy. Jour. Forestry 51: 911.

7. Home Made Gadgets Aid Forest-Influences Research by Burley D. Fridley, Jour. Forestry 51: 907-908.